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They have produced historians, and poets, and criticks, and painters, of the first class, and these, not as the authors of the Universal History assert, 'like grapes in Siberia and contrary to the usual course of nature,' but in numbers, which, when considered in reference to the size and population of the country, are not exceeded by any other nation. A respectable periodical work has indeed pronounced of them, 'that the Muses seem ever to have chosen the Netherlands for their favourite retreat.'* And though this may be saying too much, we are persuaded that in the walks of genius and taste, their claims are far from inconsiderable. Their language, it is true, is harsh and dissonant. We are assured, however, by those, who understand all its varieties, that the work, we have been reviewing, is an eminent proof, how much a skilful writer may do, by attention in the choice and arrangement of his words, towards remedying this evil. Their native literature has, no doubt, greatly suffered from the habit, which their scholars have had, of writing in the Latin language, to the neglect of their own.

We could willingly enlarge upon these subjects; but we are afraid of having already passed our proper limits. We shall, therefore, leave for the present the literary pretensions of the Dutch, and close with quoting the encomium bestowed on them by their most distinguished countryman, to a part of which, at least, we hope this view of their history may have proved them to be entitled.

'Thus,' says De Witt in his *Interests of Holland*, 'are diligence, vigilance, valour and frugality, not only natural to the Hollanders themselves, but by the nature of their country, are communicated to all foreigners, who inhabit amongst them.'

ART. VII. *Ferguson's Astronomy, explained upon Sir Isaac Newton's principles, with notes, and supplementary chapters. By David Brewster, LL. D. Fellow of the Royal Society of Edinburgh, and of the Society of Antiquaries of Scotland.* Philadelphia, A. Small, 1817. 2 vols. 8vo. with a 4to vol. of plates.

IT is now about seventy years since this work first appeared, and it has, we believe, received no material alteration since the edition of 1770, this being the last that was revised by the author. It has passed through ten editions in England and two in this country. It would be difficult to name a book on Astronomy that has had so extensive a circulation. Its chief merit is plainness and perspicuity. It requires little or no preparatory study, and seldom reminds the reader how many things there are already known, which he is not permitted to see, and how many yet remain to be discovered. The author indeed is strictly popular not only in his language and style, but in his choice of topicks, in his resources, and in the general character and furniture of his mind. He was a man of little intellectual cultivation, and no enlarged views of the subjects on which he wrote. He was principally distinguished for his mechanical ingenuity, by which he contrived to illustrate some of the leading phenomena of the planetary system. He made the best use of orreries and planetariums, which owe much of the little value they possess to his invention and skill. These artifices are very proper in the first stages of instruction, or where there are no other means of access to the mind of the learner. They are to the more refined methods what hieroglyphicks are to alphabetical writing. The facts which they teach, are accompanied with a thousand errours and gross conceptions. Wheels and pinions give but a poor idea of the simple, harmonious operations of gravity, that powerful all-pervading energy, by which the celestial fabrick is connected and sustained. A mechanical panorama may represent some of the more prominent features of a city or of a battle ; but there are other phenomena, which it does not exhibit, less obvious indeed, but of a deeper interest, on which these depend ; of which we have some traces in the works of the painter and statuary.

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* Il semble que les Muses l'ont toujours choisi pour asile.' *Hist. des Ouvrages des Savans*, 1687.

Ferguson professes to teach astronomy upon Sir Isaac Newton's principles, and one learns from him about as much of the Principia, as he learns of the Iliad by reading the arguments prefixed to the several books, or of a play of Shakspeare, by reading the story on which it is founded. He undertakes to teach a science, which owes all the refinement and perfection to which it has attained to mathematicks, without any considerable aid from this subsidiary branch of knowledge. It is principally owing to this circumstance, we think, that the book has been so long and so much used. The reader is gratified at being able to go through a work of such high pretensions, without meeting any thing that he does not understand, and without suspecting, that he has not advanced far enough to discover where the difficulties are, or in what they consist.

We confess we were surprised at seeing another impression of this work, edited by Dr. Brewster. We thought we had made some advances, not only in the more abstruse and difficult parts of the science, but also in the methods of simplifying it, and rendering it intelligible and interesting to common readers. Are all the researches, the improvements, and the speculations of the last half century, by which this science has been extended and illustrated, so entirely lost to the world at large? Are these lights destined to remain forever in the horizon, to gild only here and there a summit, which lifts itself above the general level?

It is time to present Astronomy, not only to the senses and the memory, but to the understanding and imagination, to exhibit it not merely as a collection of facts, phenomena, and tables, but as a delineation of the progress of the human mind. It is no longer to be regarded as the science of almanack making merely, as furnishing rules to the mariner, the geographer, and chronologist, but as a history of human efforts, speculations and inventions.

In the phenomena of the heavens we see a great problem held up as a sort of challenge to every nation of every age. It has called forth the greatest talents. It is the subject, on which the understanding has been exercised with the most brilliant success, and in which we trace the development and perfection of some of its noblest powers. It affords a scale on which we compare the genius, the skill, and the attainments of different nations and of different periods; and what is not the smallest recommendation to Europeans and the descendants of Europeans, it furnishes the most indubitable proofs of our intellectual superiority over all other people who have cultivated this science.

The philosophers of ancient times applied themselves to the study of the heavens, with the most laudable zeal and perseverance. We trace some of their earliest and rudest efforts, and their fantastical taste, in the constellations, the oldest monuments of human ingenuity, monuments which have remained undisturbed by the revolution of states, and untarnished by time.

We delight to look down upon the Newtons and Herschels of former times, struggling with difficulties, which no longer exist, and feeling their way as it were in the dark, among objects, which to us appear in broad day light.

The ancient astronomers, however, made some important discoveries; they advanced several steps toward disentangling this mighty maze. But they left the work incomplete; nay more, they committed some great mistakes, and came finally to a conclusion, that was radically false.

Soon after the introduction of Astronomy into Europe, it assumed a new form. In the course of one or two centuries, it is enriched with more discoveries than all that had been made before. The heavens become quite another spectacle, not only to the understanding, but to the senses. New worlds burst upon the sight, and old ones expand to a thousand times their former dimensions; those little stars that twinkle over our heads, become immense globes, with land and water, mountains and vallies, encompassed by atmospheres, enlightened by moons, and diversified by day and night and summer and winter. Beyond these are other suns, giving light and life to other systems, not a thousand or two thousand merely, but more than can be numbered; the imagination is bewildered and lost in the attempt to explore and fathom them. All space seems to be illuminated, and every particle of light a world. When we look for our sun, with its attendant planets, amid those regions of brightness, it is scarcely to be discerned. Its extinction would make no perceptible void. How small then this little speck, the earth, and how much smaller we who inhabit it. But we are more than consoled for this insignificance of our corporeal extension, by the enlargement, and elevation and dignity of the sphere of the mind.

Not only have modern discoveries extended our view of the heavens. They have unfolded the order and relation of the several parts to each; instead of making the earth the central and most important part of the system, we have given this place to the sun, which is to the earth as a mountain to a pebble, and restored the earth to the class of planets, to which it is so nearly allied by its opacity, its form, its annual and diurnal motions. We have also annihilated all that cumbrous and complicated machinery, which the ancients supposed necessary to support the planets and to carry them round in their orbits. These bodies are now upheld without any scaffolding of our contriving; they are borne along self-supported, without noise, without interference, and without errour, and all this by a power the most familiar to every one, and according to a law the most simple and the most perfectly adapted to the order and perpetuity of the whole system.

In the mean time the Eastern nations have been engaged by methods and instruments of their own invention in solving this same problem. Indeed they had made considerable progress in it long before it was thought of in Europe. Their tables refer to an epoch more than three thousand years before the christian era, and it is thought by some, who are competent judges, that they had a highly improved astronomy at this early period. We have but lately learned, that what we give Copernicus and Kepler and others the credit of discovering was well known before to our brethren of the East, and we owe the very knowledge of these facts to our attainments in astronomy, and the consequent improvement of navigation and the extension of commerce. We had been admiring the same phenomena, had been perplexed with the same difficulties, our eyes had been directed to the same stars, and our thoughts to the same contemplations and the same results, without any communication with each other. We now welcome them with the more cordiality on account of our common labours, and we learn with pride that though younger scholars in the same school, we have; have far outstripped them. Our researches have gone more deeply and thoroughly into the subject. Our knowledge is in every respect more precise and more extensive. We have not transported ourselves to the other planets, but we have, as it were, brought the other planets to us; we have been able to view them as we view a distant mountain, or a balloon in our atmosphere. By the invention of the telescope we have acquired a power that is like a new sense,—a sense, by which space is annihilated and remote invisible bodies are brought before us and subjected to our inspection. We claim also a high distinction on account of our instruments for measuring time and determining with exactness the positions of the heavenly bodies. But our greatest boast is the invention of the calculus, and the application of it to the mechanical phenomena of the heavens.

This not only brings before us the geometrical forms and dimensions and phases and inequalities of surface of the heavenly bodies, but it reveals the secret cause of their motions; it unlocks this grand orrery, and exposes all the curious and wonderful mechanism, by which the parts are connected and propelled, the trains of wheels, the arbors, the flies and checks, by which motion is communicated, and apparent irregularities produced and controlled; it lays open to the naked view the coils of that spring, by which the operations of this vast machine are maintained, a spring whose power knows no relaxation, or intermission, or limit. Nay, it does more; it informs us not only of the present state of things around us, but of what has been, and what is to be. It enables us, as it were, to turn this machine ourselves, to bring back the ages that are past, and to roll on those that are to come, to trace the accumulated effect of causes through thousands of years, and which require many thousand of years for their full development, and of causes, too, whose influence makes a part of our physical condition, and is felt at our firesides. It is, in short, to time what the telescope is to space. It transports us into the immensity of duration, and we look back upon the few moments marked by the history of man, as we look down from the stars upon the little scene of his habitation.

We have spoken of the character of Ferguson's work, considered as a popular treatise. We allow that it contains a good deal of instruction, and in a style that is adapted to a certain class of readers. But since astronomy, from being an art, has has come to be an accomplishment, an important part of our intellectual discipline, we require and ought to have a very different kind of a book. Much improvement, we are confident, might be made in point of perspicuity by more attention to arrangement and method. The subject would admit of a style less repulsive to persons of cultivated minds and polite reading, than that of the greater part of our scientifick treatises. Much yet remains, we think, to be effected in this department of literary labour.

We do not expect to see the elaborate researches of our great astronomers by any magick of words brought within the reach of common readers. If we were to be visited by an inhabitant of another planet, we should probably be able to hold no communications with him except by very slow degrees, as we learn to communicate with the deaf and dumb. So it is with a person, who makes great discoveries of an intellectual nature in this. To possess ourselves of them we must discover them ourselves. We may derive aid and facilities from those, who have gone before us. But no interpretation is to be looked for, which will save us the labour of thinking.

The ascent must be made and the summit gained; the prospect cannot be brought down. The way, however, may be smoothed and adorned, and rendered shorter and more agreeable by society. It would require a second Newton to disclose to the world, what he and a few others have unfolded only to their own minds.

But the good understanding and fellowship, which now so happily unite all classes of men of letters, like intercourse between individuals of different nations, of different languages and modes of thinking, will tend to assimilate them to each other, and to render the treasures of each common to the rest. Knowledge and taste will be more frequently united and more widely diffused. The lapse of a few centuries has changed the face of society, and given it the aspect of intelligence, activity, and cheerfulness. Literature is becoming the business of the world; a certain portion of it, like a certain style of dress, has come to be reckoned among the necessaries of life, and this portion is every day becoming greater and greater. The man of fortune and rank, the fine gentleman and the fine lady, and the man of business, are each obliged, whether he will or not, to pay his tribute to custom. We are under a conscription, that allows no substitute, but requires the personal active service of a considerable proportion of the community. Every body is beginning to read, to invent, to make experiments and speculate. The race is thronged, and every day adds new competitors. What will be the ultimate fruits of all this, it is idle to conjecture. 'It were unwise to be sanguine, and unphilosophical to despair.' What may be done, we can best judge, by what has already been accomplished. The Alps have been passed by an army incumbered with the heavy implements of war. Who knows but that the heights of science may be scaled by the multitude, who now survey them at a distance, and that a highway may be opened for the curious but less hardy traveller.

It remains to give some account of the additions to the work before us by the Editor. They are intended to supply the defects of the author, by bringing up the history of Astronomy to the present time. They consist principally of a mere description of the optical discoveries of the last half century, and of the theories that have been proposed respecting them. These discoveries relate to the five new planets, the spots on the sun, the inequalities, atmosphere and other phenomena of the Moon, Mercury, Venus, and Mars, and the immense tracts brought to light and explored in the region of the fixed stars. Some very general account also is given of the aberration of the heavenly bodies, the nutation of the earth's axis, the precession of the equinoxes and variation of the obliquity of the ecliptick. These are many of them compiled anew from original papers in English, French and German, and in general, so far as we can judge, from those, which are the most recent and of the best authority, but with very little labour on the part of the compiler. The information that is given is for the most part in a crude state. The business of condensing and elaborating it, remains to be performed by the reader. We have long details of observations from Dr. Herschel and Schroeter, copied out at full length, that are of very little value to the general student. More than a fourth part of these additions consists of mere tables of the observer's minutes, the substance of which might have been contained in a few pages, but which not one reader in a hundred would ever think of sifting for himself. These are of use only to the astronomer, and ought to be confined to books of reference. They were proper enough in the Encyclopedia, edited by Dr. Brewster, from which these supplementary chapters are principally taken.

As much of the information, which Dr. Brewster has here collected, is not to be found in the common works on Astronomy, we shall subjoin a number of extracts, both on account of the novelty of the matter, and as a specimen of what the book contains.

The following are Dr. Brewster's introductory remarks, and general view of the progress of Astronomy, since the time of Mr. Ferguson.

'The great additions which astronomy has lately received, have given a new form to this interesting science, and extended our knowledge far beyond the limits of the system which we inhabit. The discovery of five primary, and eight secondary planets;—the determination of the motion of our system in free space;—the reference of all the celestial phenomena, and particularly of the inequalities arising from the mutual action of the planets, to the simple law of gravitation; and the consequent improvement of our astronomical tables, form a lasting monument to the industry and genius of their authors; and mark the close of the first, and the commencement of the present century, as the most brilliant period in the history of astronomy.

For several of these important discoveries, we are indebted to the powerful telescopes of Dr. Herschel, which detected two of the satellites of Saturn, and all the satellites of the Georgium Sidus.* The success of this celebrated astronomer gave birth to a spirit of observation and inquiry, which was before unknown. The heavens have been explored with the most unwearied assiduity, and this laudable zeal for the advancement of astronomy has been crowned with the discovery of *four* new planets.

These additions to the science do not merely present us with a few insulated facts similar to those with which we were formerly acquainted. They exhibit to us *new and unexpected phenomena, which destroy that harmony in the solar system which appeared in the magnitudes and distances of the planets, and in the form and position of their orbits.* The six planets which formerly composed the system, were placed at somewhat regular distances from the sun. They moved from west to east, and at such intervals as to prevent any extraordinary derangements which might arise from their mutual action. Their magnitudes, too, with the exception of Saturn [and Mars,] increased with their distance from the centre of the system, and the excentricity, as well as the inclination of their orbits, was comparatively small. In the present system, however, we find four very small planets between the orbits of Mars and Jupiter, placed at nearly the same distance from the sun, and moving in *very excentric orbits* which intersect each other, and are greatly inclined to the plane of the ecliptick. The satellites of the Georgium Sidus, too, move nearly at right angles to the plane of his orbit; and what is still more surprising, the direction of their motion is opposite to that in which all the other planets, whether primary or secondary, circulate round their respective centres.' pp. 121, 122.

Dr. Brewster resumes the subject of the new planets in a subsequent chapter, and states a conjecture of Dr. Olbers respecting them, as the foundation of an hypothesis of his own, relative to the origin of meteorick stones.

'The existence of four planets between the orbits of Mars and Jupiter, revolving round the sun, at nearly the same distances, and differing from all the other planets in their diminutive size, and in the form and position of their orbits, is one of the most singular phenomena in the history of astronomy. The incompatibility of these phenomena with the regularity of the planetary distances, and with the general harmony of the system, naturally suggests the opinion, that the inequalities in this part of the system were produced by some great convulsion, and that the four planets are the fragments of a large celestial body which once existed between Mars and Jupiter. If we suppose these bodies to be independent planets, as they must be, if they did not originally form one, their diminutive size, *the great eccentricity* and inclination of their orbits, and their numerous intersections, when projected on the plane of the ecliptic, are *phenomena absolutely inexplicable on every principle of science, and completely subversive of that harmony and order which, before the discovery of these bodies pervaded the planetary system.* But if we admit the hypothesis that these planets are the remains of a larger body, which circulated round the Sun, nearly in the orbit of the greatest fragment, the system *resumes to order*, and we discover a regular progression in the distances of the planets, and a general harmony in the form and position of their orbits. To a mind capable of feeling the force of analogy, this argument must have no small degree of weight, and might be reckoned *a sufficient foundation for a philosophical theory.* We are fortunately, however, not left to the guidance merely of analogical reasoning. The elements of the new planets furnish us with several direct arguments, drawn from the *eccentricity* and inclination of their orbits, and from the position of their perihelion and nodes, and all concurring to shew that the four new planets have diverged from one point of space, and have, therefore, been originally combined in a larger body.

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* This planet with us is generally called Herschel, in the Nautical Almanack the Georgian, on the continent of Europe, Uranus. R.

'To those who are acquainted with physical astronomy, it is needless to state the difficulty of ascertaining the paths of four bodies, whose masses are known, and which have diverged from one common node, with velocities given, in quantity and direction. This problem is much more perplexing than the celebrated problem of three bodies, and is therefore beyond the grasp of the most refined analysis. It is not difficult, however, to ascertain, in general, the consequences that would arise from the bursting of a planet, and to determine within certain limits the form and position of the orbits, in which the larger fragments would revolve round the Sun.

'When the planet is burst in pieces by some internal force capable of overcoming the mutual attraction of the fragments, it is obvious that the larger fragment will receive the least impetus from the explosive force, and will, therefore, circulate in an orbit deviating less than any other of the fragments from the original path of the large planet; while the *lesser* fragments, being thrown off with greater velocity, will revolve in orbits more eccentric, and more inclined to the ecliptic. Now, the eccentricity of Ceres and Vesta is nearly one-twelfth of their mean distance, *that of*

Ceres being rather the greatest [smallest]; and the eccentricity of Pallas and Juno is one-fourth of their mean distance, *the eccentricity of Pallas being a little greater* [smaller] *than that of Juno.* We should therefore expect, from the theory, that Pallas and Juno would be considerably smaller than Ceres and Vesta, and that Ceres should be the larger fragment, and should have an orbit more analogous in eccentricity and inclination than that of any of the smaller fragments to the other planets of the system. In so far as the diameters of the new planets have been measured, *the theory is most strikingly confirmed by observation.* According to Dr. Herschel, the diameter of Ceres is 163 miles, while that of Pallas is only 80. The observations of Schroeter make Juno *considerably less than Ceres*; and though the diameter of Vesta has not been accurately ascertained, yet the intensity of its light, and the circumstance of its being distinctly visible to the naked eye, are strong proofs that it exceeds in magnitude both Pallas and Juno. The striking resemblance between the two *lesser* fragments, Pallas and Juno, in their magnitudes, and in the *extreme eccentricity of their orbits*, would lead us to anticipate similar resemblances in the position of their nodes, in the place of their perihelia, and in the inclination of their orbits; while the elements of Ceres and Vesta should exhibit similar coincidences. Now, the inclination of Ceres is 10°, and that of Vesta 7°; while the inclination of Juno is 21° [15°], and that of Pallas 34°; the two greater fragments having nearly the same inclination, and keeping near the ecliptic, while the *lesser* fragments diverge from the original path, and rise to a great height above the ecliptic, and far above the orbits of all the other planets in the system.

'In the position of the nodes, we perceive the same coincidence. The orbits of Pallas and Juno cut the ecliptic in the same point, and the nodes of Ceres and Vesta *are not far distant.*

'If all the fragments of the original planet had, after the explosion, been attracted to the larger fragment, it is obvious that they would all move in the same orbit, and consequently have the same perihelion. If the fragments received a slight degree of divergency from the explosive force, and moved in separate orbits, the points of their perihelion would not coincide, and their separation would increase with the divergency of the fragments. But, since all the fragments partook of the motion of the primitive planet, the angle of divergency could never be very great; and therefore we should expect that all the perihelia of the new planets would be in the same quarter of the heavens. *This theoretical deduction is most wonderfully confirmed by observation.* ——— All the perihelia are in the same semicircle, and all the aphelia in the opposite semicircle: the perihelia of the two larger fragments, Ceres and Vesta, being near each other [76° distant], as might have been expected, while there is the same proximity [60°] between the perihelia of the *lesser* fragments, Pallas and Juno.

'These singular resemblances in the motions of the greater fragments, and in those of the *lesser* fragments, and the striking coincidences between theory and observation in the eccentricity of their orbits, in their inclination to the ecliptic, in the position of their nodes, and in the places of their perihelia, are phenomena which could not possibly result from chance, and which concur to prove, with an *evidence amounting almost to demonstration*, that the four new planets have diverged from one common node, and have therefore composed a single planet.

'Let us now proceed to consider the other phenomena which might be supposed to accompany this great convulsion. When the cohesion of the planet was overcome by the action of the explosive force, a number of little fragments, detached along with the greater masses, would, on account of their smallness, be projected with very great velocity; and being thrown beyond the attraction of the larger fragments, might fall towards the Earth when Mars happened to be in the remote part of his orbit. The central parts of the orignal planet being kept in a state of high compression by the superincumbent weight, and this compressing force being removed by the destruction of the body, a number of *lesser* fragments might be detached from the larger masses, by a force similar to the first. These fragments will evidently be thrown off with the greatest velocity, and will always be separated from those parts which formed the central portions of the primitive planet. The detached fragments, therefore, which are projected beyond the attraction of the larger masses, must always have been torn from the central parts of the original body; and it is capable of demonstration, that the superficial or stratified parts of the planet could never be projected from the fragments which they accompany.

'When the portions which are thus detached arrive within the sphere of the Earth's attraction, they may revolve round that body at different distances, and may fall upon its surface, in consequence of a diminution of their centrifugal force; or, being struck by the electric fluid, they may be precipitated on the Earth, and exhibit all those phenomena which usually accompany the descent of meteoric stones. Hence we perceive the reason why the fall of these bodies is sometimes attended with explosions, and sometimes not; and why they generally fall obliquely, and sometimes horizontally, a direction which they never could assume, if they descended from a state of rest in the atmosphere, or had been projected from volcanoes on the the surface of the Earth.' pp. 488—494.

We quote this, not because we consider the hypothesis here advanced as at all probable, but as an instance of the looseness, inaccuracy, and extravagance of Dr. Brewster's statements and reasonings. This whole argument is obviously built upon the supposition of a known and very marked difference in the magnitudes of Ceres and Vesta, compared with those of Pallas and Juno, by which the eccentricity of the orbits of the latter, and their deviation from the plane of the ecliptick are to be explained. The lighter bodies it is presumed would suffer the greater aberration. The similarity also of the orbits of the first two, and of the last two, is supposed to arise respectively from a similarity in their masses or quantities of matter. But the diamters of Ceres and Vesta, as given by Dr. Brewster, are 1024 and 238 miles respectively, and those of Pallas and Juno, 2099 and 1425.*

Now these are far from corresponding with the known elements of the orbits. The observations of Schroëter, as given by Delambre, for three of these planets, considered as reduced to the mean distance of the earth from the sun, are for Ceres 3·482″, for Pallas 4·504″, and for Juno 3·057″. At this time Vesta was not known. Its apparent diameter has since been estimated at 0·488″ by Schroëter. According to these observations, and they are those which Dr. Brewster professes to use, the smallest of the four are Juno and Vesta, of which the latter is not one sixth part of the former, and not one eighth of the larger of the other two. Yet Dr. Brewster speaks all along of Ceres and Vesta, as the two largest, and Pallas and Juno as the smallest ; and grounds the whole of his speculation upon this assumption. 'The striking resemblance,' says he, 'between the two smaller fragments, Pallas and Juno, in their magnitudes,' &c. Again he says, 'It is *obvious*, that the larger fragments will receive the least impetus from the explosive force, and will therefore circulate in an orbit deviating less than any of the other fragments, from the original path of the large planet, while the smaller fragments, being thrown off with greater velocity, will revolve in orbits more eccentrick and more inclined to the ecliptick.'

This mode of reasoning, if it could be regarded as sound, taken in connexion with the actual magnitudes of these planets, would overthrow the hypothesis, as will be evident by looking for a moment at Dr. Brewster's own account of the elements of their orbits. But, in the first place, it should be recollected, that the observations of the apparent diameters, from which the supposed magnitudes are deduced, cannot be considered, as by any means certain. These little bodies appear like mere points, even with good telescopes ; and to undertake to compare their magnitudes, is like undertaking to compare the spider's most attenuated threads. Vesta may be seen by the naked eye ; and yet, Dr. Herschel says, he could not perceive the real disc with a power of 636. Besides, we believe, that this supposition, with regard to the origin of the small planets, is considered as attended with insurmountable difficulties.—Lagrange, indeed, favoured the suggestion so far as to calculate the velocity required to project these bodies, and he found it about twenty times that of a cannon ball. Laplace takes no notice of it in the last edition of his System of the World, in which he gives some account of these new planets. Biot says, that, 'the theory of attraction shows this hypothesis to be inadmissible, because the same explosive force would give to the different fragments, proceeding from the same point, unequal projectile velocities ; from these velocities there would result an inequality in the longer axes of their orbits, which is contrary to observation.'*

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* Dr. Herschel's estimates for Ceres and Pallas, are 163 and 80.

Lastly, we have to complain of Dr. Brewster, for representing these new planets as so very anomalous and subversive of the order and harmony, that before existed in the solar system. He frequently speaks of their eccentricities, as particularly remarkable, and a circumstance by which they are distinguished from the old planets. How he could fall into such a mistake, it is difficult to conceive ; for, according to his own table, that of two of them is about one fourth of the mean distance, and that of each of the other about one twelfth, while the eccentricity of Mercury is one fifth, and that of Mars about one eleventh. Two of the new planets, therefore, have orbits less elliptical than those of Mercury and Mars, and very much less than that of the former ; and the orbits of the other two exceed that of Mercury in this respect only, by the difference between one fourth and one fifth. The new planets, therefore, are clearly not distinguished as a class by this circumstance.

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* The semitransverse axes of their orbits are for Ceres 2·767406, Pallas 2·767592, Juno 2·667163, Vesta 2·373000, that of the earth being 1.

The *inclination* of their orbits is a more distinctive feature. They each depart farther from the ecliptick, than any of the old planets, but this excess with respect to one of them, Vesta, amounts only to a small part of a degree, and in no instance is it so great, as exists between Mercury and most of the other old planets; so that if a line is to be drawn with reference solely to this element, it ought to be drawn so as to include Mercury and perhaps Venus—almost any where, rather than between Mercury and Vesta.

The *magnitude* of the new planets has been considered as the most remarkable feature about them; but if we may rely on our estimates, they bear a greater proportion to the smaller planets before known, than these do to Jupiter and Saturn.—Ceres, Pallas, and Juno according to the best observations are in point of bulk about one seventh of that of Mercury: whereas Mercury is only one twentieth of that of the earth, and the earth, only one twelve hundredth of that of Jupiter. If the planets are to be divided into two classes on account of their difference of magnitude, the line is sufficiently well marked. The first would comprehend only Jupiter, Saturn, and Herschel, and we should be obliged to form three or four classes in order fairly to exclude these unfortunate strangers from our society, and put them by themselves.

We think, therefore, since the points we have stated have been regarded, as the most essential, that we may consider the question as settled, and conclude, that there is nothing to be apprehended from this accession to the number of planets, either as to our own dignity or the order and harmony of the system. We think moreover, that it is not very consistent in Dr. Brewster to undertake to vindicate the order and harmony of the system, by supposing, that that order and harmony no longer exist; that the constitution of this system was such, that a large and beautiful planet, after pursuing its course regularly and quietly, with a proper obliquity and eccentricity for many ages, all at once burst like a bomb shell, and spread around its powder and dust for many millions of miles; and that, instead of it, we have now, and are to have henceforth, these miserable little fragments driven at random through the celestial spaces without any regard to analogy or fitness. When, or by what power this explosion took place, or what became of the inhabitants, does not appear. If any of them should happen to accompany portions of their *natale solum* to our earth we should probably learn something more.

Dr. Brewster recurs in another place to this hypothesis to explain a circumstance, which we have not noticed, namely, that two of the new planets have very extensive atmospheres, while the other two have apparently none. He admits, that this is a difficulty not easily accounted for upon the supposition that they were once united. He takes occasion, therefore, from a comet passing somewhere near the region of the paths of these bodies, about the year 1770, to furnish the extra quantities of this fluid. This reminds us of the romantick days of Whiston.

For our own parts, we are perfectly ready to receive these celestial guests, and as many more as may present themselves, as *bona fide* planets and intitled to all the consideration and respect, which we pay to our older associates, and so far from marring the beauty and order of this association, to which we belong, we think that they add to it by adding to its variety. It was once thought that the planets could not exceed seven in number, either because there are seven stars in a remarkable cluster, or because there are seven musical divisions in the octave, or for some other reason about as good. The discovery of the planet Hershel produced almost as great a derangement as that of the smaller planets. It was another exception to the gradation of magnitude following the increase of distance. It was an interruption to the law of specifick gravities decreasing with the distances. Its satellites were found, in violation of all analogy, to have their orbits nearly perpendicular to the ecliptick, and what was still worse, they performed their motions contrary to the order of the signs. We begin to be reconciled to these apparent anomalies, and future discoveries may erect them into rules. All this proceeds from our notions of what is orderly, harmonious and fit, being derived from our limited knowledge, from a little narrow system in our own minds, which every new discovery requires to be altered and re-adjusted, or to be taken entirely to pieces and made over again ; and it is not the least of the advantages of the study of Astronomy, that in so many instances it exposes our partial views and lurking prejudices. The discipline has an influence beyond the sphere in which it is received. We bring a more liberal mind to other inquiries.

There is another speculation, in which Dr. Brewster maintains that the sun is not inhabited, as some have been led to suppose from the observations of Dr. Herschel, which indicate an atmosphere and strata of dark and luminous clouds elevated far above his surface. One of the reasons, which he gives, is, that the inhabitants would be precluded from the study of Astronomy ; and another is, that the sun is an exception to the law of specifick gravities, forgetting, that these specifick gravities have been certainly determined only with respect to those planets that have satellites. We are not disposed to enter into a discussion of this question, believing, as we do, that we have not the materials for forming any satisfactory conclusion on the subject.

We shall give a few extracts as specimens of Dr. Brewster's manner, when his aim is merely to instruct. His style forms a striking contrast to that of Mr. Ferguson.

'It appears, that the lunar surface is not only diversified with rocks and cavities, but that some parts of it are distinguished from others by their superiour illumination. The dark parts of the Moon's disc are always smooth, and apparently level ; while the luminous portions are elevated tracts, which either rise into high mountains, or sink into deep and extensive cavities. The general smoothness of the obscure regions naturally induced astronomers to believe that they were immense collections of water. The names given by Hevelius are founded on this opinion ; and notwithstanding the discoveries which have been made on the surface of the Moon, it is still very generally maintained among modern astronomers. When we examine the Moon's disc, however, with minute attention, we find that these obscure portions are not exactly level like a fluid surface. In many of them the inequality of surface and of light is considerable ; and in some parts, parallel ridges are distinctly visible. The large dark spot on the Moon's western limb, which is called the Crisian Sea, appears in general to be extremely level ; but we have frequently observed, when the Moon was a little past her opposition, and when the boundary of light and darkness passed through the Crisian Sea, that this bounding line, instead of being elliptical, as it would have been had the surface been fluid, was irregular, and evidently indicated that this portion of the Moon's disc was actually elevated in the middle. The light of these obscure regions, likewise, varies very much, according to the angle of illumination, or the altitude of the Sun above their horizon ; and when the Moon is near her conjunction, they are not much less luminous than the other parts of her disc. Now this could never happen if they were covered with water ; for when a fluid surface is not ruffled by the wind, the light of the Sun, or rather the image of the Sun could not be seen, unless when the eye of the observer was in the line of the reflected rays.

It would appear, therefore, from these facts, that there is no water in the moon, neither rivers, nor lakes, nor seas, and hence we are entitled to infer, that none of those atmostpherical phenomena, which arise from the existence of water in our own globe, will take place in the lunar world.

'The strata of mountains, and the insulated hills which mark the disc of this luminary have evidently no analogy with those in our own globe. Her mountainous scenery, however, bears a stronger resemblance to the towering sublimity, and the terrific ruggedness of Alpine regions, than to the tamer inequalities of less elevated countries. Huge massess of rock rise at once from the plains, and raise their peaked summits to an immense height in the air, while projecting crags spring from their rugged flanks and threatening the valleys below, seem to bid defiance to the laws of gravitation. Around the base of these frightful eminences are strewed numerous loose and unconnected fragments, which time seems to have detached from their parent mass; and when we examine the rents and ravines which accompany the over-hanging cliffs, we expect every moment that they are to be torn from their base, and that the process of destructive separation which we had only contemplated in its effects, is about to be exhibited before us in tremendous reality. The strata of lunar mountains called the Appennines, which traverse a portion of her disc from north-east to south-west, rise with a precipitous and craggy front from the level of the Mare Imbrium. In some places their perpendicular elevation is above four miles; and though they often descend to a much lower level, they present an inaccessible barrier to the north-east, while on the south-west, they sink in gentle declivity to the plains.

'The analogy between the surface of the Earth and Moon fails in a still more remarkable degree, when we examine the circular cavities which appear in every part of her disc. Some of these immense caverns are nearly four miles deep and forty miles in diameter. A high annular ridge, marked with lofty peaks and little cavities, generally encircles them; an insulated mountain frequently rises in their centre, and sometimes they contain smaller cavities of the same nature with themselves. These hollows are most numerous in the south-west part of the Moon; and it is from this cause that that portion of this luminary is more brilliant than any other part of her disc. The mountainous ridges, which encircle the cavities, reflect the greatest quantity of light; and from their lying in every possible direction, they appear near the time of full Moon like a number of brilliant radiations, issuing from the large spot, called Tycho.

'It is difficult to explain, with any degree of probability, the formation of these immense cavities; but we cannot help thinking, that our Earth would assume the same figure, if all the seas and lakes were removed ; and it is therefore probable, that the lunar cavities are either intended for the reception of water, or that they are the beds of lakes and seas which have formerly existed in that luminary. The circumstance of there being no water in the Moon is a strong confirmation of this theory.'

Dr. Brewster closes his supplement with a table, containing the elements of the orbits of the planets and several other particulars. In this, we are surprised to find, that he has not availed himself of the later corrections and improvements.—We have, for instance, the longitude of the nodes for the year 1750, the inclination of the orbits, without the variation, for 1780, and the place of the aphelia for 1801, printed 1800; whereas the practice has been for some time to refer all these to the beginning of the present century, and to give the place of the perihelia instead of that of the aphelia for the sake of preserving a uniformity in this respect between the planets and comets. The secular variations of the nodes and aphelia are given not according to the latest corrections, and the reader is left to find out as he can when they are additive, and when subtractive, and whether they are absolute, or whether they are to be referred to the equinox. The eccentricities are in parts of the earth's mean distance considered as 100000, instead of being expressed in parts of the semi-major axes respectively. There are morever some important mistakes, besides such as are evidently typographical. The Moon's mass is stated to be 0·025, instead 0·0146, and that of Mars at 0·0875 instead of 0·1294, the earth's being considered as 1. On the whole, this table, which is a sort of an abtract of the author's view of the subject, when compared with similar ones given by Laplace, Biot, Delambre, or by Mr. Woodhouse, will be found to be more or less incorrect in a greater part of the articles contained in it.

We have adverted to what we conceive the most exceptionable parts of the editor's labours. In others, he has given abundant proof of learning and extensive research ; and the matter, which he has collected, appears to us, for the most, to be well arranged. His style is perspicuous, and animated, and more highly wrought than we generally meet in productions of this nature. He is sometimes, however, a little too lofty, and too ambitious of rhetorical ornament.

We have confined ourselves principally in the remarks we have offered, to the faults and defects of this work, in the hope that some exertions may be made towards procuring one more respectable, and more worthy of the nature and present state of the science. Were we already supplied with such a treatise, adapted to the higher class of readers, we should not regret the republication of this, as it may be useful in academies and schools, and to a large description of persons whose education and pursuits do not lead them to inquiries of a more refined and difficult character.

ART. VIII. *Inaugural Address, delivered in the Chapel of the University at Cambridge, November 5, 1817. By Levi Frisbie, A. M. Alford Professor of Natural Religion, Moral Philosophy, and Civil Polity in Harvard University.* University Press, Hilliard & Metcalf, 1817.

WE in this country have great reason to congratulate ourselves upon the rapid improvement, which has taken place within a few years in the state of our literature. Without doubt, there is not in any nation, so large a proportion of readers of some degree of cultivation and refinement. One of the most striking evidences of our literary improvement is to be found in the character of many of our popular addresses, which indicate at once the talents of the speaker, and the estimate which he has formed of the information, good taste, and good sense of those whom he is addressing. Of these it would be impossible to select a more favourable specimen, than the discourse now under review, which, though pronounced before the University in Cambridge, upon the occasion of the author's inauguration as Professor,* may yet be regarded as a *popular address*, when we consider the numerous audience which attends upon such occasions. It is partly as affording evidence of the good state of our literature, that we are desirous of directing the publick attention to it; but principally on account of its intrinsick value. We are persuaded that so far as we are able to make it more known, we are doing service to the cause of letters, and of morals.

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* See our last number, p. 146.